

CLAIMS

1. Film compositions that comprise, as a conductive phase, pyrochlore-related compounds of the general formula  $M_{2-x} Cu_x Ru_2 O_{6+\delta}$ , wherein M is a rare earth metal selected from the rare earth metals of atomic number 60-71 inclusive.
2. Compositions according to claim 1, wherein X = 0.2 - 0.4 and  $\delta$  = 0-1.
3. Compositions according to claim 1, comprising a dielectric phase.
4. Compositions according to claim 3, wherein the dielectric phase consists of or comprises, as a main component, a glass phase.
5. Compositions according to claim 4, wherein the glass phase comprises by mole% 40-60%  $SiO_2$ , 1-20%  $B_2O_3$ , 1-15%  $BaO$ , 1-6%  $SrO$ , 1-15%  $CaO$ , 0.5-3%  $CuO$ , 0.5-20%  $ZnO$ , 0.25-7%  $M_2O_3$ , 0.25-4%  $M'^2O$ , wherein M' is Li, Na, K or mixture thereof, and M is a rare earth element of atomic number 57 to 71 inclusive, or mixture thereof; and 0-3% of a metal fluoride in which the metal is selected from the group consisting of alkali and alkaline earth metals.
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6. Compositions according to claim 4, wherein the glass phase comprises by mole% 40 to 65%  $SiO_2$ , 10 to 20%  $Bi_2O_3$ , 0.1 to 3%  $Al_2O_3$ , and glass modifiers in total amount of 15 to 25%, wherein said glass modifiers comprise 1 to 23%  $ZnO$ , 0.1 to 5%  $CuO$ , 0.1 to 5%  $CaO$  and 0.1 to 2%  $MgO$ .
7. Compositions according to claim 4, wherein the glass phase comprises a blend of two glasses.
8. Compositions according to claim 7, wherein
  - a) a first glass comprises by mole% 40-65%  $SiO_2$ , 1-15%  $B_2O_3$ , 12-27%  $BaO$ , 5-10%  $SrO$ , 5-15%  $CaO$ , 0-5%  $MgO$ , 0-5%  $Al_2O_3$ , 0-

12% alkali metal oxides and 0-3% of a metal fluoride in which the metal is selected from the group consisting of alkali and alkaline earth metals; and

b) a second glass comprises by mole% glass forming compounds in a total amount of 75 to 85% wherein, said glass forming compounds comprise 40 to 65%  $\text{SiO}_2$ , 10 to 20%  $\text{Bi}_2\text{O}_3$ , 0.1 to 3%  $\text{Al}_2\text{O}_3$ , and glass modifiers in total amount of 15 to 25%, wherein said glass modifiers comprise 1 to 23%  $\text{ZnO}$ , 0.1 to 5%  $\text{CuO}$ , 0.1 to 5%  $\text{CaO}$  and 0.1 to 2%  $\text{MgO}$ .

9. Compositions according to claim 3 or 4, wherein the dielectric phase is selected from  $\text{Al}_2\text{O}_3$ ,  $\text{SiO}_2$ ,  $\text{ZrSiO}_4$ ,  $\text{ZrO}_2$ , aluminosilicates and mixtures thereof.

10. Compositions according to claim 1, further comprising an organic vehicle.

11. Compositions according to claim 10, wherein the organic vehicle is a solution of resin in a solvent or mixture of solvents.

12. Compositions according to claim 1, further comprising a filler.

13. Compositions according to claim 12, wherein the filler is chosen from the group consisting of  $\text{Al}_2\text{O}_3$ ,  $\text{SiO}_2$ ,  $\text{ZrSiO}_4$ ,  $\text{ZrO}_2$  and aluminosilicates.

14. Compositions according to claim 1, comprising  
a) a dispersion of finely divided particles of the pyrochlore - related compound corresponding to the formula  $\text{M}_{2-x} \text{Cu}_x \text{Ru}_2 \text{O}_{6+\delta}$ , wherein M is a rare earth metal selected from the rare earth metals of atomic number 60-71 inclusive,  $X = 0.2 - 0.4$ ,  $\delta = 0-1$  ;

b) glasses according to claims 5, 6, 7, 8, and mixtures thereof; and

c) dielectrics selected from the group consisting of  $\text{SiO}_2$ ,  $\text{ZrSiO}_4$  and  $\text{Al}_2\text{O}_3$ .

15. Compositions according to claim 14, wherein the rare earth metal is Neodymium.

16. A composition according claim 4, wherein the glass phase comprises glasses chosen from the group consisting of Cd-free and Pb-free bismuthate glasses, alkaline earth borosilicate glasses, and mixture thereof.

17. A composition according to claim 4, wherein the glass phase is chosen from the group consisting of lead-containing silicate glasses, lead-containing borosilicate glasses and mixtures thereof.

18. Method of preparing pyrochlore-related compounds as defined in claim 1, which comprises firing an admixture of finely divided particles of  $\text{CuO}$ ,  $\text{RuO}_2$  and a metal oxide selected from the rare earth metal oxides of atomic number 60 -71 inclusive, at a temperature of at least  $800^\circ\text{C}$ , in a non-reducing atmosphere.

19. Method according to claim 18, for preparing compounds having the formula  $\text{Nd}_{2-x} \text{Cu}_x \text{Ru}_2 \text{O}_{6+\delta}$ , which comprises firing in air an admixture of finely divided particles of  $\text{Nd}_2\text{O}_3$ ,  $\text{CuO}$  and  $\text{RuO}_2$  at a temperature of  $1000-1200^\circ\text{C}$ .

20. Method of making film compositions according to claim 1, comprising preparing a powdered mixture of

a) 5-90% by weight of an oxide of the formula  $\text{Cu}_x \text{M}_{2-x} \text{Ru}_2 \text{O}_{6+\delta}$ , wherein M is a rare earth metal selected from the rare earth metals of atomic number 60-71 inclusive, x is a number in the range of 0.25 to 0.4, and  $\delta$  is a number in the range of 0 to 1; and

b) 95-10% by weight of dielectric materials.

21. Method according to claim 20, further comprising dispersing the powdered mixture in a liquid organic vehicle.
22. Method according to claim 20, wherein the oxide is chosen from the group consisting of  $\text{Nd}_{1.70} \text{ Cu}_{0.30} \text{ Ru}_2 \text{ O}_{6+\delta}$ ,  $\text{Nd}_{1.75} \text{ Cu}_{0.25} \text{ Ru}_2 \text{ O}_{6+\delta}$ , and their mixtures wherein  $\delta$  is a number in the range of 1 to 0.
23. Method according to claim 22, wherein the dielectric materials are chosen from the group consisting of glasses, oxides selected from  $\text{ZrSiO}_4$ ,  $\text{Al}_2\text{O}_3$ ,  $\text{SiO}_2$ , and mixture thereof.
24. Film compositions, substantially as described and illustrated.
25. Method of preparing pyrochlore-related compounds as defined in claim 1, substantially as described and illustrated.
26. Method of making film compositions according to claim 1, substantially as described and illustrated.